



# Health Hazard Evaluation Report

HETA 86-159-1909  
HUBINGER COMPANY, INC.  
KEOKUK, IOWA

## PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

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HUBINGER COMPANY, INC.  
KEOKUK, IOWA

NIOSH INVESTIGATOR:  
Bobby J. Gunter, Ph.D., CIH

## I. SUMMARY

In January, of 1986 the National Institute for Occupational Safety and Health (NIOSH) received a request from the American Federation of Grain Millers Local 48, to evaluate occupational exposures during the processing of corn and corn products at the Hubinger company in Keokuk, Iowa. Five cases of multiple sclerosis were reported among the current and former work force.

A walk-thru survey was conducted on February 3, and 4, 1988. The environmental investigation was performed on March 17, 18, and 19, 1988. During the environmental investigation breathing zone and general room air samples were collected for epichlorohydrin, hydrochloric acid (HCl), hydrofluoric acid (HF), nitric acid (HNO<sub>3</sub>), phosphoric acid (H<sub>3</sub>PO<sub>4</sub>), sulfuric acid (H<sub>2</sub>SO<sub>4</sub>), total particulate, crystalline silica (quartz, cristobalite), and sulfur dioxide (SO<sub>2</sub>). One breathing zone and four general area samples were collected for epichlorohydrin; all concentrations were below detection limits except one general area sample which was at the detection limits of 0.01 mg/sample (approximately 0.1 mg/M<sup>3</sup>). Three time weighted average (TWA) air samples were collected and analyzed for HCl, HF, HNO<sub>3</sub>, H<sub>3</sub>PO<sub>4</sub>, and H<sub>2</sub>SO<sub>4</sub>. HF and HNO<sub>3</sub> were below the laboratory limits of detection, HCl and H<sub>3</sub>PO<sub>4</sub> were well below the NIOSH and OSHA evaluation criteria. H<sub>2</sub>SO<sub>4</sub> exceeded the OSHA standard and the ACGIH TLV of 1 mg/M<sup>3</sup> in two of the three samples (2.5 and 2.0 mg/M<sup>3</sup>). Seven samples were collected for total particulate, and respirable free silica (quartz, cristobalite). All total particulate concentrations were less than 0.1 of the evaluation criteria. One breathing zone sample exceeded the NIOSH evaluation criteria for respirable quartz, the concentration was 0.09 mg/M<sup>3</sup>, the NIOSH criteria is 0.05 mg/M<sup>3</sup>. Eleven of 13 general room air samples (ranging from 0.5 to 28.7 mg/M<sup>3</sup>) collected for SO<sub>2</sub> exceeded the NIOSH evaluation criteria of 1.3 mg/M<sup>3</sup>. These samples were collected in areas where workers do not spend an entire work day, but usually work several minutes and then leave the exposure. These levels were high enough that even when passing through such areas workers should have adequate respiratory and eye protection.

Direct reading detector tubes were also used for epichlorohydrin, ammonia, and SO<sub>2</sub>. Epichlorohydrin was not found; ammonia was found in trace concentrations in the 1st and 3rd floor of the stripping area; SO<sub>2</sub> concentrations were identical to those observed in the long term samples with values all exceeding the NIOSH and OSHA evaluation criteria.

On the basis of environmental data obtained during this investigation, it was concluded that a health hazard exists from exposures to crystalline silica, epichlorohydrin, sulfuric acid, and sulfur dioxide. One overexposure to crystalline silica was found on a worker and high general room air concentrations of the other three chemicals were observed. Recommendations for engineering controls and respiratory protection are provided in this report.

Keywords: SIC 2046 ( Wet Corn Milling ) Epichlorohydrin, crystalline silica, Sulfuric acid, sulfur dioxide, and phosphoric acid.

## II. INTRODUCTION

In January 1986, NIOSH received a request from the American Federation of Grain Millers, Local 48, in Keokuk, Iowa to evaluate occupational exposures that might occur during the wet milling of corn and production of food products such as fructose, corn oil, corn germ and corn starch. Worker representatives were concerned about five cases of multiple sclerosis among current and previous workers at this facility. A walk-thru survey was conducted in February 1988 and an environmental investigation was completed in March 1988.

## III. BACKGROUND

This facility takes corn and separates the starch from the grain by soaking the kernel in warm water for a considerable period of time. When the kernel reaches the proper stage of softness, it is crushed and strained through sieves. The milky fluid is transported over a series of surfaces resulting in the heavier parts of the corn being left behind while the lighter particles flow into the settling tanks. The starch is dried and ready for shipment or use in making another product. During the soaking of the corn sulfur dioxide is added to prevent fermentation. Various acids are added in order to prevent fermentation and aid in the digestion of the starch and in the production of other products. Epichlorohydrin is used occasionally in the production of special orders of a specific starch. Above the starch dryers in an area referred to as the steeps is where most of the exposures to sulfur dioxide, hydrochloric acid, sulfuric acid and phosphoric acid, are most likely to occur. These chemicals escape during the drying of the wet starch. Workers do not work a full 8-hours in the steeps, but do enter these areas briefly 6 or 7 times during a work shift to check the area and for maintenance of the equipment.

The areas where most exposures are likely to occur include; starch production, starch drying, and in the grain elevators and the conveying of the dry grain to the starch department.

## IV. ENVIRONMENTAL DESIGN AND METHODS

Epichlorohydrin was collected on organic vapor charcoal tubes using vacuum pumps operated at 50 cc/minute, and analyzed by the NIOSH method 1010 with modifications.

Hydrochloric, hydrofluoric, sulfuric, nitric, and phosphoric acids were collected on orbo-53 collection tubes using vacuum pumps operated at 50-100 cc/minute and then analyzed according to NIOSH method 7903.

Total particulate samples were collected on preweighed filters and analyzed by weight difference using an electrobalance. Crystalline silica (quartz, Cristobalite) was collected on FWSB filters using cyclones and vacuum pumps operated at 1.7 liters per minute. These samples were analyzed using x-ray diffraction according to NIOSH method 7500.

Sulfur dioxide measurements were made using long term detector tubes and vacuum pumps operated at 20 cc/minute, calculations were made at the work site.

Ventilation measurements were not made since there were no local exhaust systems. Roof top fans, open windows, and open doors helped reduce and in some cases eliminate exposures. Additional ventilation is needed in the steeps area.

Most of the workers have worked in this facility for a long time (over 10 years). Conversations with most of the workers did not indicate that they were concerned with occupational exposures.

## V. ENVIRONMENTAL CRITERIA

### A. Environmental

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended exposure limits (RELs), by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

The environmental evaluation criteria for individual chemical contaminants monitored during this investigation are presented in Table 1. Recommended environmental limits and human health effects concerning each substance are listed in the table, along with the source of the recommended limits and the present OSHA standard.

## VI. ENVIRONMENTAL RESULTS AND DISCUSSION

Tables 2 thru 5 present results of area and personal sampling for epichlorohydrin, HCl, HF, HNO<sub>3</sub>, H<sub>3</sub>PO<sub>4</sub>, H<sub>2</sub>SO<sub>4</sub>, total particulate, crystalline silica (quartz), and SO<sub>2</sub>.

### 1. Epichlorohydrin

Epichlorohydrin was found in one of five air samples. The concentration of epichlorohydrin was 0.1 mg/M<sup>3</sup>. This is below the OSHA standard of 19 mg/M<sup>3</sup>; however NIOSH considers epichlorohydrin to be a human carcinogen and recommends the lowest feasible limit (LFL). This was a general room air sample.

### 2. Hydrochloric acid (HCl), hydrofluoric acid (HF), nitric acid (HNO<sub>3</sub>), and sulfuric acid (H<sub>2</sub>SO<sub>4</sub>)

All acid samples with the exception of sulfuric were below the evaluation criteria. In two of three samples taken for sulfuric the NIOSH and OSHA criteria were exceeded. Levels were 2.5 mg/M<sup>3</sup>, and 2.0 mg/M<sup>3</sup>; the evaluation criteria is 1 mg/M<sup>3</sup>.

### 3. Total Particulate and Crystalline silica (quartz, cristobalite)

Seven breathing zone air samples were collected for total particulate and crystalline silica. All total particulate samples were below the evaluation criteria. One crystalline silica sample exceeded the NIOSH recommended level of 0.05 mg/M<sup>3</sup>. All concentrations for total particulate and crystalline silica were below the OSHA standards.

### 4. Sulfur Dioxide (SO<sub>2</sub>)

Eleven of thirteen general room air samples exceeded the NIOSH evaluation criteria of 1.3 mg/M<sup>3</sup>, and 8 of the thirteen samples exceeded the OSHA evaluation criteria of 13 mg/M<sup>3</sup>.

## **VII. CONCLUSIONS**

Results of the air sampling illustrate that there are areas in the steeps and in dry grain handling where overexposures can occur. Overexposures to epichlorohydrin would be unlikely; since it is not used often and only one or two workers enter the area for very brief periods. Respiratory protection and protective gloves should be worn when workers are working around the epichlorohydrin. Acid exposure can occur in the steeps and in the A and B refining area. Sulfuric and phosphoric exposures were of concern since high concentrations of sulfuric were observed and concentrations of phosphoric were elevated. These were area samples but illustrate that the potential for overexposure exists and workers should be protected if they work in these areas for an extended period. One worker out of seven monitored for total particulate and free crystalline silica was overexposed to quartz. This worker was working with the dry corn prior to processing. There are times when the corn may be dusty and this dust always has the potential of being contaminated with crystalline silica. Respiratory protection should be provided to the workers in the grain elevators to protect them from overexposures. Worker representatives were concerned about five cases of multiple sclerosis among current and previous workers at this facility. Multiple sclerosis has no known occupational etiology and chemicals used in this facility do not have known neurotoxic effects. Since the multiple sclerosis issue could not be resolved, the best help NIOSH could provide was a good industrial hygiene exposure study.

## **VIII. RECOMMENDATIONS**

1. A comprehensive respirator program that complies with the OSHA standard 1910.134 should be developed for the entire facility.
2. Workers should not enter the steeps area without acid gas filters on their respirators. This would eliminate exposure to sulfur dioxide and the other acid gases.
3. All plant employees should be briefed on the toxicology of all chemicals used in plant production areas.
4. Addition of engineering controls (more local exhaust ventilation in the steeps, building 7, 7B, 20) would assist in reducing SO<sub>2</sub> levels.
5. Eating and smoking should be eliminated in all production areas.

## **IX. REFERENCES**

1. NIOSH Pocket Guide to Chemical Hazards, DHEW (NIOSH) Publication No. 78-210.
2. Industrial Hygiene and Toxicology, second edition, Frank Patty (editor), Interscience Publishers, 1967, Vol. II.

**X. AUTHORSHIP AND ACKNOWLEDGEMENTS**

Report Prepared By: Bobby J. Gunter, Ph.D., CIH  
Regional Industrial Hygienist  
NIOSH - Denver Regional Office  
Denver, Colorado

Field Assistance By: Anne T. Nichting, CIH  
Industrial Hygienist  
NIOSH - Denver Region  
Denver, Colorado

Originating Office: Hazard Evaluations and Technical  
Assistance Branch  
Division of Surveillance, Hazard  
Evaluations and Field Studies (DSHEFS)  
Cincinnati, Ohio

Report Typed By: Marile F. DiGiacomo  
Secretary  
NIOSH - Denver Regional Office  
Denver, Colorado

**XI. DISTRIBUTION AND AVAILABILITY**

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from NIOSH, Publications Office, at the Cincinnati address.

Copies of this report have been sent to:

1. Hubinger Company, Inc.
2. U.S. Department of Labor/OSHA - Region VII
3. NIOSH - Denver Region
4. Iowa Department of Health
5. State Designated Agency

For the purpose of informing affected employees, a copy of this report shall be posted in a prominent place accessible to the employees for a period of 30 calendar days.



Table 1  
Evaluation Criteria and Toxicology  
Humbinger Company, Inc.  
Keokuk, Iowa

Substance	Primary Health Effects	Reference Source	Recommended Environmental Limit <sup>A</sup>	OSHA Standard
Epichlorohydrin	Nausea, vomiting, abdominal pain, respiratory distress, cough, cyanosis, eye irritation, NIOSH considers Epichlorohydrin a human carcinogen.	NIOSH	LFL	19
Hydrochloric Acid (HCl)	Ear, eyes, nose, & throat irritant. Lung & respiratory tract irritant.	OSHA/ACGIH	7 mg/M <sup>3</sup>	7 mg/M <sup>3</sup>
Hydrofluoric Acid (HF)	Eye, nose, throat irritant, pulmonary edema, nerve damage, if not treated properly.	NIOSH	3.3 mg/M <sup>3</sup>	3.3 mg/M <sup>3</sup>
Nitric Acid (HN <sub>3</sub> )	Irritates eyes, mucous membranes, delayed pulmonary edema, erodes tract.	NIOSH/	5 mg/M <sup>3</sup>	5 mg/M <sup>3</sup>
Phosphoric Acid (H <sub>3</sub> PO <sub>4</sub> )	Irritates upper respiratory tract, eyes, dermatitis producer.	OSHA	1 mg/M <sup>3</sup>	1 mg/M <sup>3</sup>
Sulfuric Acid	Eye, nose, throat irritation, pulmonary edema, bronchial emphysema, dental erosion, dermatitis.	NIOSH/	1 mg/M <sup>3</sup>	1 mg/M <sup>3</sup>
Total Particulate	Irritates eyes, & mucous membranes.	ACGIH	10 mg/M <sup>3</sup>	15 mg/M <sup>3</sup>
Crystalline Silica (Quartz)	Silicosis, cough, wheezing, progressive symptoms with prolonged exposure.	NIOSH	0.05 mg/M <sup>3</sup>	10 mg/M <sup>3</sup> XS10 <sub>2</sub> +2
Sulfur Dioxide (SO <sub>2</sub> )	Irritated eyes, nose, throat rhinitis, choking, eye burns, bronchoconstriction.	NIOSH	1.3 mg/M <sup>3</sup>	13 mg/M <sup>3</sup>

Table 2

Breathing Zone and General Area Air Concentrations of  
Epichlorohydrin at  
Hubinger Company, Inc.  
in Keokuk, Iowa  
March 17, 1988

Sample #	Job/General Area	Location	Sampling Time	Mg/M <sup>3</sup> Epichlorohydrin
E-1	General Area	Mixing Tank	8:31 - 3:14	*
E-2	Lab Technician	Lab/Mixing	8:32 - 3:16	*
E-3	General Area	Mixing Tank	8:33 - 3:14	A 0.1
E-10	General Area	#1 Tank	7:47 - 2:07	*
E-20	General Area	#1 Tank	7:47 - 2:06	*

## Evaluation Criteria

LFL

Laboratory Limit of Detection mg/sample

0.01

A = trace was equal to detection limit 0.01 in sample then divided by air volume of 48.6 liters = 0.1 mg/M<sup>3</sup>

\* = Below detection limit of 0.01 mg/sample

LFL = Lowest Feasible Limit

Table 3

Breathing Zone and General Area Air Concentrations of  
 Hydrochloric Acid, Hydrofluoric Acid, Nitric Acid,  
 Phosphoric Acid, and Sulfuric Acid at  
 Hubinger Company, Inc.  
 in Keokuk, Iowa  
 March 17, 1988

Sample #	Location	Sampling Time	Hcl	HF	mg/M <sup>3</sup>		H <sub>2</sub> SO <sub>4</sub>
					HNO <sub>3</sub>	H <sub>3</sub> PO <sub>4</sub>	
A-1	WmD-Special Tank	8:24 - 3:14	.04	*	*	0.23	2.5
A-2	A&B Refinery/Tech	8:50 - 3:08	.06	*	*	0.27	0.7
A-3	A&B Refinery/C.Rm.	8:46 - 3:06	<u>0.03</u>	<u>*</u>	<u>*</u>	<u>0.68</u>	<u>2.0</u>
Evaluation Criteria			7	2.5	5	1.0	1.0
Laboratory Limit of Detection ug/sample			.9	2	2	10	4

Table 4

Breathing Zone and General Area Air Concentrations of  
Total Particulate and Crystalline Silica (Quartz, Cristobalite) at  
Hubinger Company, Inc.  
in Keokuk, Iowa  
March 17, 18, 1988

Sample #	Job	Location	Sampling Time	mg/M <sup>3</sup>	Free Silica	
				Particulate	Quartz	Cristo.
FW6145	Operator	Corn loading	7:50 - 2:38	0.06	*	*
FW6139	Foreman	Corn Elevator	7:52 - 2:38	0.35	*	*
FW6140	Corn Shoveler	Truck Dump	7:53 - 2:41	0.43	0.03	*
FW6144	Cleanup	All Areas	7:55 - 2:46	0.90	0.03	*
FW6124	Corn Shoveler	All Areas	8:00 - 2:40	1.80	0.09	*
FW6452	Starch Packer	Old Starch Pk	8:02 - 2:10	2.4	*	*
FW6459	Starch Packer	New Starch Pk	8:11 - 2:12	4.0	*	*
Evaluation Criteria				10	0.05	0.05
Laboratory Limit of Detection mg/sample				0.01	0.015	0.015

Table 5

Breathing Zone and General Area Air Concentrations of  
Sulfur Dioxide (SO<sub>2</sub>) at  
Hubinger Company, Inc.  
in Keokuk, Iowa  
March 17, 18, 19, 1988

Sample #	Job	Location	Sampling Time	Mg/M <sup>3</sup> SO <sub>2</sub>
1	General Area	Steep Area/Bldg. 7	8:13 - 11:01	5.7
2	General Area	Bldg. 7/Top of Steep	8:17 - 11:08	21.1
3	General Area	Bldg. 20/Top of Steep	8:20 - 11:15	17.7
4	General Area	Bldg. 7/Upper Steep	11:03 - 2:56	7.8
5	General Area	Bldg. 7B/Top of Steep	11:12 - 1:03	19.6
6	General Area	Bldg. 20/Top of Steep	11:17 - 1:00	20.6
7	General Area	Bldg. 20/Top of Steep	1:02 - 3:00	27.1
8	General Area	Bldg. 7B/Top of Steep	1:04 - 2:58	29.8
9	General Area	Bldg. 7/Near Central Rm.	7:54 - 11:59	22.7
10	General Area	Bldg. 7/Computer Rm.	7:50 - 12:04	0.5
11	General Area	Bldg. 7/Near Central Rm.	7:55 - 12:01	28.7
12	General Area	Bldg. 7/Near Central Rm.	12:03 - 2:03	11.0
13	General Area	Bldg. 7/Central Rm.	12:05 - 2:04	<u>1.0</u>
Evaluation Criteria				1.3
Limit of Detection				